LEGEND: **DRAFT 05/18/15**
Text to be *[deleted]* is in italics and bracketed.
**Black bold** text is added from 10 States Standards Chapter 40 2014.
**Blue bold** text is added from 10 CSR 20-8.020(10).
**Orange bold** text is added for clarification.
Underline text is added since the previous stakeholder meeting on April 22, 2015.

# Title 10—DEPARTMENT OF NATURAL RESOURCES
## Division 20—Clean Water Commission
## Chapter 8—Design Guides

### 10 CSR 20-8.130 *[Sewage]* Pumping Stations.

*PURPOSE: The following criteria have been prepared as a guide for the design of [sewage]* ***wastewater*** *pumping stations. This rule is to be used with rules 10 CSR 20-8.110[–]* ***through*** *10 CSR 20-8.220 for the planning and design of the complete treatment facility. This rule reflects the minimum requirements of the Missouri Clean Water Commission [as]* ***in*** *regard[s]* ***to*** *adequacy of design, submission of plans, approval of plans and approval of completed [sewage works]* ***wastewater treatment facilities. It is not reasonable or practical to include all aspects of design in these standards. The design engineer should obtain appropriate reference materials which include but are not limited to: copies of all ASTM International standards pertaining to wastewater pumping stations and appurtenances, design manuals such as Water Environment Federation's Manuals of Practice, and other wastewater pumping station design manuals containing principles of accepted engineering practice.*** *Deviation from these minimum requirements will be allowed where sufficient documentation is presented to justify the deviation. These criteria are taken largely from Great Lakes-Upper Mississippi River Board of State [Sanitary Engineers]* ***and Provincial Public Health and Environmental Managers*** *Recommended Standards for [Sewage Works]* ***Wastewater Facilities*** *and are based on the best information presently available. These criteria were originally filed as 10 CSR 20-8.030. It is anticipated that they will be subject to review and revision periodically as additional information and methods appear. [Addenda or supplements to this publication will be furnished to consulting engineers and city engineers. If others desire to receive addenda or supplements, please advise the Clean Water Commission so that names can be added to the mailing list.]*
*Editor's Note: The secretary of state has determined that the publication of this rule in its entirety would be unduly cumbersome or expensive. The entire text of the material referenced has been filed with the secretary of state. This material may be found at the Office of the Secretary of State or at the headquarters of the agency and is available to any interested person at a cost established by state law.*

(1) Definitions. Definitions as set forth in the Clean Water Law and 10 CSR 20-2.010 shall apply to those terms when used in this rule, unless the context clearly requires otherwise. Where the terms **"**shall**"** and **"**must**"** are used, they are to mean a mandatory requirement insofar as approval by the *[agency]* **Missouri Department of Natural Resources (department)** is concerned, unless justification is presented for deviation from the requirements. Other terms, such as **"**should,**"** **"**recommend,**"** **"**preferred,**"** and the like, indicate *[discretionary requirements on the part of the agency and deviations are subject to individual]* **the preference of the department for** consideration **by the design engineer**.

**(A) Deviations. Deviations from these rules may be approved by the department when engineering justification satisfactory to the department is provided. Justification must**

**substantially demonstrate in writing and through calculations that a variation(s) from the design rules will result in either at least equivalent or improved effectiveness. Deviations are subject to case-by-case review with individual project consideration.**
**(B) Pump Station. A pump station is designed to move wastewater from lower to higher elevation through pipes or conduits. The key components are pumps, valves, and electrical equipment. A pump station is considered part of a sanitary sewer system that is operated and maintained by one of the continuing authorities listed in 10 CSR 20-6.010(3)(B).**
**(C) Force Main. A force main is a pipe or conduit that conveys wastewater under pressure from the discharge side of a pump to a discharge point. A force main is considered part of a sanitary sewer system that is operated and maintained by one of the continuing authorities listed in 10 CSR 20-6.010(3)(B).**

*[(2) Exceptions. This rule shall not apply to facilities designed for twenty-two thousand five hundred (22,500) gallons per day (85.4m$^3$) or less, see 10 CSR 20-8.020 for the requirements for those facilities.]*

**(2) Applicability. This rule shall apply to all pumping stations and force mains. This rule shall supersede when there is a conflict with 10 CSR 20-8.020.**

(3) General.
(A) Flooding. *[Sewage]* **Wastewater** pumping station structures and electrical and mechanical equipment shall be protected from physical damage by **not less than one foot (1') (0.3m) above** the one hundred (100)-year flood **elevation or one foot (1') (0.3m) above the highest historical flood elevation, whichever is higher**. *[Sewage]* **Wastewater** pumping stations should remain fully operational and accessible during the twenty-five (25)-year flood.
(B) Accessibility. The pumping station shall be readily accessible by maintenance vehicles during all weather conditions. The *[facility]* **pumping station** should be located off the traffic way of streets and alleys. **An all-weather access road shall be provided from a public right-of-way to all pumping stations. Sufficient room shall be provided at the site to permit turning vehicles around.**
**(C) Siting. Ultimate land use, noise control, odor control, and other items shall be taken into consideration. Sites for pumping stations should be of sufficient size for maintenance and future expansion of addition, if applicable.**
**(D) Security. The design of a pump station, including all mechanical and electrical equipment, must restrict access by an unauthorized person, discourage vandalism, and prohibit the entrance of animals. It is recommended that security fencing and access hatches with locks be provided. Also refer to 10 CSR 20-8.140(9)(A)1.**
*[(C)]* **(E)** Grit. Where it is necessary to pump *[sewage]* **wastewater** prior to grit removal, the design of the wet well and pump station piping shall receive special consideration to avoid operational problems from the accumulation of grit.

**(F) Safety. Adequate provision shall be made to effectively protect maintenance personnel from hazards. During design, safety provisions should be made to ensure that federal, state, and local safety codes can be met during construction, operation and maintenance of the pump station. Also refer to 10 CSR 20-140(9).**
**(G) Potable Water Sources. The distance between wastewater pumping stations and all potable water sources should be one hundred feet (100') (30.5 m) and shall be at least fifty feet (50') (15.2 m) in accordance with 10 CSR 23-3.010(2)(A)5.**
**(H) Housed Wet Wells. Where wet wells are in a housed building, fixed fresh air vents shall be provided. Dampers shall not be used on exhaust or fresh air ducts. Continuous fresh air shall be introduced at a rate of twelve (12) air changes per hour when occupied by personnel.**
**(I) Erosion Control During Construction. Effective site erosion control shall be provided during construction. Erosion control activities shall obtain a stormwater permit for land disturbance activities that meet the requirements of the land disturbance permit, in accordance with 10 CSR 20-6.200.**
**(J) Grading and Landscaping. Upon completion of construction, the ground should be graded and either sodded or seeded. Where possible, steep slopes should be avoided to prevent erosion and to minimize slips, trip, and falls. Surface water shall not be permitted to drain into any pump station.**

(4) Design. **The following items shall be given consideration in the design of wastewater pumping stations.**

*[(A) Type. Sewage pumping stations should be of the wet/dry well type. Other types as set forth under sections (5) and (6) of this rule may be approved where circumstances justify their use.]*

**(A) Type. Wastewater pumping stations in general use fall into four (4) types: wet well/dry well, submersible, suction lift, and screw pump.**

(B) Structures.

1. Separation. Dry wells, including their superstructure, shall be completely separated from the wet well. **Common walls shall be gas tight.**
2. Equipment removal. Provision**s** shall be made to facilitate removing pumps, motors**,** and other mechanical and electrical equipment. **Individual pump and motor removal shall not interfere with the continued operation of the remaining pumps. Components located inside buildings or other structures shall be removable without affecting the structural integrity of the building.**
3. Access **and safety landings**.

**A. Access.** Suitable and safe means of access **for persons wearing self-contained breathing apparatus** shall be provided to dry wells and to wet wells**. Access to wet wells** containing either bar screens or mechanical equipment requiring inspection or maintenance **equipment requiring inspection or maintenance shall conform to Paragraph 61.13. Also refer to 10 CSR 20-140(9).**

**B. Safety landings.** For built-in-place pump stations, a stairway *[with rest landings]* **to the dry well** shall be provided **with rest landings** at vertical intervals not to

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exceed twelve feet (12') (3.7 m). For factory-built pump stations over fifteen feet (15') (4.6 m) deep, a rigidly fixed landing shall be provided at vertical intervals not to exceed ten feet (10') (3*[.0]* m). Where a landing is used, a suitable and rigidly fixed barrier shall be provided to prevent *[an]* individual**s** from falling past the intermediate landing to a lower level. *[Where approved by the agency, a]* **A** manlift or elevator may be used in lieu of landings in a factory-built station, provided emergency access is included in the design. Reference should be made to *[local, state and]* federal**, state, and local** safety codes and, if they are more stringent, they shall govern (also see 10 CSR 20-8.140(8)(F)).

**4. Buoyancy. Where high groundwater conditions are anticipated, buoyancy of the wastewater pumping station structures shall be considered and, if necessary, adequate provisions shall be made for protection.**

*[4.]* **5.** Construction materials. *[Due consideration shall be given to the selection of materials because of the presence of]* **Materials shall be selected that are appropriate under conditions of exposure to** hydrogen sulfide and other corrosive gases, greases, oils**,** and other constituents frequently present in *[sewage]* **wastewater**. **This is particularly important in the selection of metals and paints. Contact between dissimilar metals should be avoided or other provisions made to minimize galvanic action.**

**6. Grit protection. Where it may be necessary to pump wastewater prior to grit removal, the wet well and pumping station piping shall be designed to avoid operational problems from the accumulation of grit.**

**(C) Septicity. When the station is expected to operate at a flow rate less than 0.5 times the average daily flow for longer than twelve (12) hours at a time, the design shall consider measures to prevent septicity due to long holding times in the wet well.**

**(D) Unit Isolation. Due consideration shall be given to the need for lifting and handling equipment available to aid in unit isolation. In addition, the placement of structures and other devices to lift and handle heavy or large components shall be considered in the design.**

*[(C)]* **(E)** Pumps *[and Pneumatic Ejectors]*.

*[1. Multiple units. At least two (2) pumps or pneumatic ejectors shall be provided. A minimum of three (3) pumps should be provided for stations handling flows greater than one (1) mgd (3800$m^3$/d). If only two (2) units are provided, they should have the same capacity. Each shall be capable of handling flows in excess of the expected maximum flow. Where three (3) or more units are provided, they should be designed to fit actual flow conditions and must be of a capacity that with any one (1) unit out-of-service the remaining units will have capacity to handle maximum sewage flows.]*

**1. Multiple units.**

**A. Multiple pumps shall be provided.**

**B. Where only two (2) units are provided, they shall be of the same size. Units shall have capacity such that, with any unit out-of-service, the remaining units will have capacity to handle the design peak hourly flow.**

**C. All pumps should be tested by the manufacturer. These tests should include a hydrostatic test and an operating test.**

**D. Single pump installations may be given consideration only for very small installations, where the average design flow of the pump station is less than fifteen hundred gallons per day (1,500 gpd) and only if the pump station is designed to permit the installation of a future duplicate unit without structural change and satisfactory means are provided to detect malfunctions and take corrective actions before an overflow to waters of the state could occur.**

2. Protection against clogging.

**A. Combined wastewater.** Pumps handling combined *[sewage]* **wastewater** shall be preceded by readily accessible bar racks to protect the pumps from clogging or damage. Bar racks should have clear openings *[not exceeding two and one-half inches (2 1/2") (6.4 cm)]* **as provided in 10 CSR 20-8.150(3)(A)3.A**. Where a bar rack is provided, a mechanical hoist shall also be provided. Where the size of the installation warrants, mechanically cleaned and/or duplicate bar racks shall be provided. **Refer to paragraph (4)(B)3. of this rule and Paragraph 61.13. Facilities with screens shall provide a method to remove, store, and dispose of screenings.**

**B. Separate sanitary wastewater.** Pumps handling separate sanitary *[sewage]* **wastewater** from thirty inches (30") (76 cm) **diameter** or larger *[diameter]* sewers shall be protected by bar racks meeting *[these]* **the above** requirements. Appropriate protection from clogging shall also be considered for small pumping stations. **Refer to paragraph (4)(B)3. of this rule and Paragraph 61.13.**

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Comment [ETC3]: This reference isn't available in the current 8.150.

3. Pump openings. Except where grinder pumps are used, pumps **handling raw wastewater** shall be capable of passing **solid** spheres of at least three inches (3") (7.6 cm) in diameter**.** *[and p]***P**ump suction and discharge *[piping]* **openings** shall be at least four inches (4") (10.2 cm) in diameter. **An exception to the requirement for passing solid spheres of at least three inches (3") (7.6 cm) in diameter may be made on a case-by-case basis when the design includes piping with a diameter at least a half inch (0.5") (1.3 cm) greater than the size of the solid sphere and equivalent protection from clogging or damage (i.e., grinder pumps, etc.).**

4. Priming. The pump shall be so placed that under normal operating conditions it will operate under a positive suction head, except as specified in section (5) of this rule.

5. Electrical equipment.

**A.** Electrical systems and components (for example, motors, lights, cables, conduits, switch boxes, control circuits, etc.) in *[enclosed]* **raw wastewater wet wells,** or **in enclosed or** partially enclosed spaces where hazardous concentrations of flammable gases or vapors may be present, *[including raw sewage wet wells,]* shall *[be suitable for hazardous locations ()* **comply with the** National Electrical Code*[,]* **(NEC) requirements for** Class I, *[Group D,]* Division 1**, Group D** location*[)]***s**.

**B.** *[In addition, e]***E**quipment located in the wet well shall be suitable for use under corrosive conditions.

**C.** Each flexible cable shall be provided with **a** watertight seal and separate strain relief.

**D.** A fused disconnect switch located above ground shall be provided for **the main power feed for** all pumping stations.

**E.** When *[the]* **such** equipment is exposed to weather, it shall meet the requirements of weather proof equipment **National Electrical Manufacturers Association** (NEMA**)** *[3R)]* **4 at a minimum and 4X where necessary**.

**F. Lightning and surge protection systems should be provided.**

**G. Pump station control panels located outdoors shall be provided with a one hundred ten volt (110 V) power receptacle inside the control panel to facilitate maintenance.**

**H. Ground Fault Circuit Interruption (GFCI) protection shall be provided for all outdoor outlets.**

6. Intake. Each pump *[should]* **shall** have an additional individual intake. Wet well **and intake** design should be such as to avoid turbulence near the intake **and to prevent vortex formation**. *[Intake piping should be as straight and short as possible.]*

7. Dry well de*[-]*watering. A *[separate]* sump pump equipped with dual check valves shall be provided in the dry well*[s]* to remove leakage or drainage with the discharge *[located as high as possible]* **above the maximum high water level of the wet well**. *[A connection to the pump suction is also recommended as an auxiliary feature.]* Water ejectors connected to a potable water supply will not be approved. All floor and walkway surfaces should have an adequate slope to a point of drainage. Pump seal *[water]* **leakage** shall be piped **or channeled directly** to the sump. **The sump pump shall be sized to remove the maximum pump seal water discharge that could occur in the event of a pump seal failure. Refer to section (8) of this rule. Sump pumps should be located to provide easy access and removal. A sump pump must operate automatically by use of a level control.**

8. Pumping rates. The pumps and controls of main pumping stations**,** *[and]* especially pumping stations *[pumping to the treatment works or]* operated as part of *[the]* treatment [works] **facilities,** should be selected to operate at varying delivery rates**.** *[to permit discharging sewage at approximately its rate of delivery to the pump station. Design pumping rates should be established in accordance with 10 CSR 20-8.120(5) or 10 CSR 20-8.140(5)(C)1. as appropriate.]* **Such stations should be designed to deliver as uniform a flow as practicable in order to minimize hydraulic surges. The station design capacity shall be based on the peak hourly flow determined in accordance with 10 CSR 20-8.110(4)(C)4. and should be adequate to maintain a minimum velocity of two feet per second (2 ft/s) (0.6 m/s) in the force main. Refer to subsection (11)(A) of this rule.**

*[(D)]* **(F)** Controls. **Water level control sensing devices should be located to prevent undue affects from turbulent flows entering the well or by the turbulent suction of the pumps. Water level controls must be accessible without entering the wet well. Bubbler type level monitoring systems shall include dual air compressors. Provision shall be made to automatically alternate the pumps in use. Suction lift stations should be designed to alternate pumps daily instead of each pumping cycle to extend the life of the priming equipment.**

*[1. Type. Control systems shall be of the air bubbler type, the encapsulated float type or the flow measuring type. Float tube control systems on existing stations being upgraded may be approved. The electrical equipment shall be suitable for hazardous locations (National Electrical Code, Class I, Group D, Division 1 location).*

*2. Location. The control system shall be located away from the turbulence of incoming flow and pump suction.*

*3. Alternation. In small stations, provisions should be made to automatically alternate the pumps in use.]*

**(G) Pipe Size. Pump suction and discharge piping shall not be less than four inches (4") (10 cm) in diameter except as approved under paragraph (4)(E)3. of this rule or where grinder pumps are used or design of specialized equipment allows. Maximum recommended velocities are six feet per second (6 ft/s) (1.8 m/s) in the suction line and eight feet per second (8 ft/s) (2.4 m/s) in the discharge line. Minimum velocity shall not be less than two feet per second (2 ft/s) (0.6 m/s) in the discharge line.**

*[(E)]* **(H)** Valves.

1. **Suction line.** Suitable shutoff valves shall be placed on the suction line of *[each pump except on submersible and vacuum primed]* **dry well** pumps.

2. **Discharge line.** Suitable shutoff and check valves shall be placed on the discharge line of each pump **(except on screw pumps)**. The check valve shall be located between the shutoff valve and the pump. Check valves shall be suitable for the material being handled **and shall be placed on the horizontal portion of discharge piping except for ball checks, which may be placed in the vertical run**. *[Check valves shall not be placed on the vertical portion of discharge piping.]* Valves shall be capable of withstanding normal pressure**s** and water hammer. *[Where limited pump backspin will not damage the pump and low discharge head conditions exist, short individual force mains for each pump may be considered in lieu of discharge valves.]* **All shutoff and check valves shall be operable from floor level and accessible for maintenance. Outside levers are recommended on swing check valves.**

3. Valves shall not be located in the wet well.

*[(F)]* **(I)** Wet Wells.

1. Divided wells. **Where continuity of pumping station operation is critical,** *[C]***c**onsideration *[should]* **shall** be given to dividing the wet well into multiple **interconnected** sections*[, properly interconnected,]* to facilitate repairs and cleaning.

*[2. Size. The wet well size and control setting shall be appropriate to avoid heat buildup in the pump motor due to frequent starting and to avoid septic conditions due to excessive detention time.]*

**2. Size.**

**A. The design fill time and minimum pump cycle time shall be considered in sizing the wet well. The effective volume of the wet well shall be based on the design average flow determined in accordance with 10 CSR 20-8.110(4)(C)4. and a filling time not to exceed thirty (30) minutes, unless the pumping station is designed to provide flow equalization. The pump manufacturer's duty cycle recommendations shall be utilized in selecting the minimum cycle time.**

**B. For constant speed pumps the minimum pump cycle volume shall be based on the formula:**

$$V = \frac{T \times Q}{4}$$

**Where:**

**V = storage volume between Pump ON and Pump OFF, gallons**
**T = required time between starts, minutes**
**Q = pump discharge capacity or the difference in flow rate between steps, gallons per minute**

**C. When the anticipated initial flow tributary to the pumping station is less than the design average flow, provisions should be made so that the fill time indicated is not exceeded for initial flows. Detention times for initial and ultimate flow conditions shall be evaluated.**

**D. When the wet well is designed for flow equalization as part of a treatment facility, provisions should be made to prevent septicity.**

3. Floor slope. The wet well floor shall have a minimum slope of one to one (1:1) to the hopper bottom. The horizontal area of the hopper bottom shall *[not]* be **no** greater than necessary for proper installation and function of the inlet.

**4. High water level. The high water level control in the wet well during normal operations shall be at least one foot (1') (0.3 m) below the invert of the incoming sewer.**

**5. Air displacement. Covered wet wells shall have provisions for air displacement to the atmosphere, such as an inverted and screened "j" tube or other means.**

*[(G)]* **(J) Safety** Ventilation.

**1. General.** Adequate ventilation shall be provided for all pump stations. **Mechanical ventilation shall be provided for dry wells that are located below the ground surface.** *[Where the pump pit is below the ground surface, mechanical ventilation is required, so arranged as to independently ventilate the dry well and the wet well i]***I**f screens or mechanical equipment requiring maintenance or inspection are located in the wet well**, permanently installed ventilation is required**. There shall be no interconnection between the wet well and dry well ventilation systems.

**2. Air inlets and outlets.** In *[pits]* **dry wells** over fifteen feet (15') (4.6 m) deep, multiple inlets and outlets are desirable. Dampers *[should]* **shall** not be used on exhaust or fresh air ducts**.** *[and f]***F**ine screens or other obstructions in air ducts should be avoided to prevent clogging.

**3. Electrical controls.** Switches for operation of ventilation equipment *[should]* **shall** be **clearly** marked and **conveniently** located *[conveniently]* **outside of the wet well**. All intermittently operated ventilating equipment shall be interconnected with the respective *[pit]* **wet well or dry well** lighting system. Consideration *[should]* **shall** be given *[also]* to automatic controls where intermittent operation is used. **The manual lighting/ventilation switch shall override the automatic controls. For a two (2) speed**

**ventilation system with automatic switch over where gas detection equipment is installed, consideration shall be given to increasing the ventilation rate automatically in response to the detection of hazardous concentrations of gases or vapors.**

**4. Fans, heating, and dehumidification.** The fan wheel *[should]* **shall** be fabricated from non-sparking material. *[Consideration should be given to installation of a]***A**utomatic heating and*[/or]* dehumidification equipment **shall be provided in all dry wells**. **The electrical equipment and components shall meet the requirements in paragraph (4)(E)5. of this rule.**

*[1.]* **5.** Wet wells. **Wet well** *[V]***v**entilation may be either continuous or intermittent. Ventilation, if continuous, shall provide at least twelve (12) complete air changes per hour*[,]***;*** if intermittent, **shall provide** at least thirty (30) complete air changes per hour. Air shall be forced into the wet well **by mechanical means** rather than **solely** exhausted from the wet well. **The air change requirements shall be based on one hundred percent (100%) fresh air. Portable ventilation equipment shall be available for use at submersible pump stations and wet wells with no permanently installed ventilation equipment.**

*[2.]* **6.** Dry wells. **Dry well** *[V]***v**entilation may be either continuous or intermittent. Ventilation, if continuous, shall provide at least six (6) complete air changes per hour*[,]***;*** if intermittent, **shall provide** at least thirty (30) complete air changes per hour. **A system of two (2) speed ventilation with an initial ventilation rate of thirty (30) changes per hour for ten (10) minutes and automatic switch over to six (6) changes per hour may be used to conserve heat. The air change requirements shall be based on one hundred percent (100%) fresh air.**

*[(H)]* **(K)** Flow Measurement. Suitable devices for measuring *[sewage]* **wastewater** flow *[should]* **shall** be *[considered]* **provided** at all pumping stations **as identified in 10 CSR 20-8.140(8)(I)**. **All pump stations shall be equipped with elapsed time meters at a minimum provided sufficient metering is configured to measure the duration of individual and simultaneous pump operation.**

*[(I)]* **(L)** Water Supply. There shall be no physical connection between any potable water supply and a *[sewage]* **wastewater** pumping station which**,** under any conditions**,** might cause contamination of the potable water supply. If a potable water supply is brought to the station, it *[should]* **shall** comply with conditions stipulated under 10 CSR 20-8.140(8)*[(B)]***(D)**.

(5) Suction-Lift Pump*[s]* **Stations**. **Suction-lift pumps shall meet the applicable requirements of section (4) of this rule.**

**(A) Pump Priming and Lift Requirements.** Suction-lift pumps shall be of the self-priming or vacuum-priming type *[and shall meet the applicable requirements under section (4) of this rule]*. Suction-lift pump stations using dynamic suction lifts exceeding the limits outlined in *[the following subsections]* **this section** may be approved by the *[agency]* **department** upon submission of factory certification of pump performance and detail**ed** calculations indicating satisfactory performance under the proposed operating conditions. **Such** *[D]***d**etail**ed**

calculations *[must]* **shall** include static suction-lift as measured from "lead pump off" elevation to center line of pump suction, friction**,** and other hydraulic losses of the suction piping, vapor pressure of the liquid, altitude correction, required net positive suction head**,** and a safety factor of at least six feet (6') (1.8 m). *[The pump equipment compartment shall be above grade or offset and shall be effectively isolated from the wet well to prevent the humid and corrosive sewer atmosphere from entering the equipment compartment. Wet well access shall not be through the equipment compartment. Valving shall not be located in the wet well.]*

*[(A)]* **1.** Self-*[P]***p**riming *[P]***p**umps. Self-priming pumps shall be capable of rapid priming and repriming at the "lead pump on" elevation. *[This]* **Such** self-priming and repriming shall be accomplished automatically under design operating conditions. Suction piping should not exceed the size of the pump suction and shall not exceed twenty-five feet (25') (7.6 m) in total length. Priming lift at the "lead pump on" elevation shall include a safety factor of at least four feet (4') (1.2 m) from the maximum allowable priming lift for the specific equipment at design operating conditions. The combined total of **the** dynamic suction-lift at the "pump off" elevation and **the** required net positive suction head at design operating conditions shall not exceed twenty-two feet (22') (6.7 m).

*[(B)]* **2.** Vacuum-*[P]***p**riming *[P]***p**umps. Vacuum-priming pump stations shall be equipped with dual vacuum pumps capable of automatically and completely removing air from the suction-lift pump. The vacuum pumps shall be adequately protected from damage due to *[sewage]* **wastewater**. The combined total of dynamic suction-lift at the "pump off" elevation and **the** required net positive suction head at design operating conditions shall not exceed twenty-two feet (22") (6.7 m).

**(B) Equipment, Wet Well Access, and Valve Location.**

**1. Equipment. The pump equipment compartment shall be above grade or offset and shall be effectively isolated from the wet well to prevent a hazardous and corrosive sewer atmosphere from entering the equipment compartment.**

**2. Wet well access. Wet well access shall not be through the equipment compartment and shall be at least twenty-four inches (24") (61 cm) in diameter. Gasketed replacement plates shall be provided to cover the opening to the wet well for pump units removed for servicing.**

**3. Valve location. Valves shall not be located in the wet well.**

(6) Submersible Pump Stations. Submersible pump stations shall meet the applicable requirements under section (4) of this rule, except as modified in this section.

(A) Construction. Submersible pumps and motors shall be designed specifically for raw *[sewage]* **wastewater** use, including totally submerged operation during a portion of each pumping cycle**, and shall meet the requirements of the NEC for such units**. An effective method to detect shaft seal failure or potential seal failure shall be provided *[and the motor shall be of squirrel-cage type design without brushes or other arc-producing mechanisms]*.

(B) Pump Removal. Submersible pumps shall be readily removable and replaceable without **personnel entering or** de*[-]*watering the wet well or disconnecting any piping in the wet well.

**(C) Ventilation. Submersible pump wet wells shall be provided with static vents if mechanical ventilation is not provided. Also refer to subsection (4)(J) of this rule.**

*[(C)]* **(D)** Electrical **Equipment**.

1. Power supply and control **circuitry**. Electrical supply**, control,** and *[control]* **alarm** circuits shall be designed to **provide strain relief and to** allow disconnection *[at a junction box located or accessible]* from outside the wet well. Terminals and connectors shall be protected from corrosion by location outside *[of]* the wet well or *[by]* **through use of** watertight seals.

2. Controls. The motor control center shall be located outside the wet well**, be readily accessible,** and be protected by a conduit seal **or other appropriate measures meeting the requirements of the NEC,** to prevent the atmosphere *[in]* **of** the wet well from gaining access to the control center. The seal shall be located so that the motor *[may]* **can** be removed and electrically disconnected without disturbing the seal. **When such equipment is exposed to weather, it shall meet the requirements of weather proof equipment NEMA 4 at a minimum and 4X where necessary.**

3. Power cord. Pump motor power cords shall be designed for flexibility and serviceability under conditions of extra hard usage and shall meet the requirements of the *[Mine Safety and Health Administration for trailing cables]* **NEC standards for flexible cords in wastewater pump stations**. Ground fault interruption protection shall be used to de-energize the circuit in the event of any failure in the electrical integrity of the cable. Power cord terminal fittings shall be corrosion resistant and *[be]* constructed in a manner to prevent the entry of moisture into the cable, shall be provided with strain relief appurtenances**,** and shall be designed to facilitate field connecting.

*[(D)]* **(E)** Valves. Valves required under subsection (4)(*[E]***H**) of this rule shall be located in a separate valve *[pit]* **chamber**. *[Accumulated water shall be drained to the wet well or to the soil. If the valve pit is drained to the wet well, an effective method shall be provided to prevent sewage from entering the pit during surcharged wet well conditions.]* **Provisions shall be made to remove or drain accumulated water from the valve chamber. The valve chamber may be dewatered to the wet well through a drain line such that gases or overflows from the wet well shall not enter the valve chamber. Check valves that are integral to the pump need not be located in a separate valve chamber provided that the valve can be removed from the wet well in accordance with subsection (6)(B) of this rule. Access shall be provided in accordance with subparagraph (4)(B)3.A. of this rule.**

**(7) Screw Pump Stations. Screw pump stations shall meet the applicable requirements of section (4) of this rule.**

**(A) Covers. Covers or other means of excluding direct sunlight shall be provided as necessary to eliminate adverse effects caused by temperature changes.**

**(B) Pump Wells. A positive means of isolating individual screw pump wells shall be provided.**

**(C) Bearings. Submerged bearings shall be lubricated by an automated system without pump well dewatering.**

**(D) Discharge Line. Suitable provisions shall be made to prevent backflow down the trough of a pump that is out-of-service.**

*[(7)]* **(8)** Alarm Systems.

**(A) General.** Alarm systems **with a backup power source** shall be provided for pumping stations. The alarm shall be activated in cases of power failure, **dry well sump and wet well high water levels,** pump failure, *[use of the lag pump, unauthorized entry]* or any **other** cause of pump station malfunction.

**(B) Transmitting System.** Pumping station alarm*[s]* **systems** shall *[be telemetered, including identification of the alarm condition,]* **transmit and identify alarm conditions** to a municipal facility that is *[manned]* **staffed** twenty-four (24) hours a day. If such a facility is not available and twenty-four (24)-hour holding capacity**, based on the design average flow,** is not provided, the alarm shall be *[telemetered]* **transmitted** to *[city]* **municipal** offices during normal working hours and to the home of the **responsible** person(s) *[responsible]* in charge of the *[lift]* **pumping** station during off-duty hours.

**(C) Audio-visual System.** Audio-visual alarm systems *[with a self-contained power supply]* may be acceptable in some cases in lieu of the *[telemetering]* **transmitting** system *[outlined in this section,]* depending upon location, station holding capacity**,** and inspection frequency **with department approval**. **A sign shall be posted at each pump station in a clearly visible location, listing a telephone number to be called if the alarm is seen or heard.**

*[(8) Emergency Operation. Pumping stations and collection systems shall be designed to prevent or minimize bypassing of raw sewage. For use during possible periods of extensive power outages, mandatory power reductions or uncontrolled storm events, consideration should be given to providing a controlled, high-level wet well overflow to supplement alarm systems and emergency power generation in order to prevent backup of sewage into basements, or other discharges which may cause severe adverse impacts on public interests, including public health and property damage. Where a controlled diversion is utilized, consideration shall also be given to the installation of storage-detention tanks or basins, which will be made to drain to the station wet well. Where overflows affect public water supplies, shellfish production or waters used for culinary or food processing purposes, a storage-detention basin or tank, shall be provided having two (2)-hour detention capacity at the anticipated overflow rate.*

*(A) Overflow Prevention Methods. A satisfactory method shall be provided to prevent or minimize overflows. The following methods should be evaluated on an individual basis. The choice should be based on least cost and least operational problems of the methods providing an acceptable degree of reliability. The methods are—*

*1. Storage capacity including trunk sewers for retention of wet weather flows. Storage basins must be designed to drain back into the wet well or collection system after the flow recedes;*

*2. An in-place or portable pump, driven by an internal combustion engine meeting the requirements of subsection (8)(B) of this rule, capable of pumping from the wet well to the discharge side of the station; and*

*3. Two (2) independent public utility sources or engine-driven generating equipment meeting the requirements of subsection (8)(B) of this rule.*

*(B) Equipment Requirements.*

*1. General. The following general requirements shall apply to all internal combustion engines used to drive auxiliary pumps, service pumps through special drives or electrical generating equipment.*

*A. Engine protection. The engine must be protected from operating conditions that would result in damage to equipment. Unless continuous manual supervision is planned, protective equipment shall be capable of shutting down the engine and activating an alarm on-site and as provided in section (7) of this rule. Protective equipment shall monitor for conditions of low oil pressure and overheating, except oil pressure monitoring will not be required for engines with splash lubrication.*

*B. Size. The engine shall have adequate rated power to start and continuously operate all connected loads.*

*C. Fuel type. Reliability and ease of starting, especially during cold weather conditions should be considered in the selection of the type of fuel.*

*D. Engine ventilation. The engine shall be located above grade with adequate ventilation of fuel vapors and exhaust gases.*

*E. Routine start-up. All emergency equipment shall be provided with instructions indicating the need for regular starting and running of the units at full loads.*

*F. Protection of equipment. Emergency equipment shall be protected from damage at the restoration of regular electrical power.*

*2. Engine-driven pumping equipment. Where permanently installed or portable engine-driven pumps are used, the following requirements in addition to general requirements shall apply:*

*A. Pumping capacity. Engine-driven pump(s) shall meet the design pumping requirements unless storage capacity is available for flows in excess of pump capacity. Pumps shall be designed for anticipated operating conditions, including suction lift if applicable;*

*B. Operation. The engine and pump shall be equipped to provide automatic start-up and operation of pumping equipment. Provisions shall also be made for manual start-up. Where manual start-up and operation is justified, storage capacity and alarm system must meet the requirements of subparagraph (8)(B)2.C. of this rule; and*

*C. Portable pumping systems. Where part or all of the engine-driven pumping equipment is portable, sufficient storage capacity to allow time for detection of pump station failure and transportation and hookup of the portable equipment shall be provided. A riser from the force main with quick-connect coupling and appropriate valving shall be provided to hookup portable pumps.*

*3. Engine-driven generating equipment. Where permanently installed or portable engine-driven generating equipment is used, the following requirements in addition to general requirements shall apply:*

*A. Generating capacity. Generating unit size shall be adequate to provide power for pump motor starting current and for lighting, ventilation and other auxiliary equipment necessary for safety and proper operation of the lift station. The operation of only one (1) pump during periods of auxiliary power supply must be justified. Justification may be made on the basis of maximum anticipated flows relative to single pump capacity, anticipated length of power outage and storage capacity. Special sequencing controls shall be provided to start pump motors unless the generating equipment has capacity to start all pumps simultaneously with auxiliary equipment operating;*

*B. Operation. Provisions shall be made for automatic and manual start-up and load transfer. The generator must be protected from operating conditions that would result in damage to equipment. Provisions should be considered to allow the engine to start and stabilize at operating speed before assuming the load. Where manual start-up and transfer is justified, storage capacity and alarm system must meet the requirements of subparagraph (8)(B)3.C. of this rule; and*

*C. Portable generating equipment. Where portable generating equipment or manual transfer is provided, sufficient storage capacity to allow time for detection of pump station failure and transportation and connection of generating equipment shall be provided. The use of special electrical connections and double throw switches are recommended for connecting portable generating equipment.]*

**(9) Emergency Operation.**

**(A) Objective. The objective of emergency operation is to prevent the discharge of raw or partially treated wastewater to any waters and to protect public health by preventing sanitary sewer overflows of wastewater and subsequent discharge to basements, streets, and other public and private property.**

**(B) Emergency Pumping Capability. Emergency pumping capability is required unless on-system overflow prevention is provided by adequate storage capacity. Emergency pumping capability shall be accomplished by connection of the pump station to at least two (2) independent utility substations, by provision of portable or in-place internal combustion engine equipment to generate electrical or mechanical energy, or by the provision of portable pumping equipment. Emergency pumping shall comply with the conditions stipulated in 10 CSR 20-8.140(8)(A). Such emergency standby systems shall have sufficient capacity to start up and maintain the total rated running capacity of the pump station.**

**(C) Portable Pump Connection. Regardless of the type of emergency standby system provided, a portable pump connection to the force main with rapid connection capabilities and appropriate valves shall be provided outside the dry well and wet well. A portable pump must be readily available to personnel.**

**(D) Portable Standby Facilities. Portable standby facilities shall only be utilized when the operating authority has responsible personnel capable of responding twenty-four (24) hours a day. If portable standby facilities are used for multiple facilities (i.e. pumping stations, City Hall, etc.) the wastewater utility shall evaluate its pump stations to determine the number and size of portable facilities needed to prevent sanitary sewer overflows during a period of power outage.**

**(E) Emergency High Level Overflows. For use during possible periods of extensive power outages, mandatory power reductions, or uncontrollable emergency conditions, consideration shall be given to providing a controlled, high-level wet well overflow to supplement alarm systems and emergency pumping capability in order to prevent backup of wastewater into basements, or other discharges that could cause severe adverse impacts on public interests, including public health and property damage. Where a high level overflow is utilized, consideration shall also be given to the installation of storage/detention tanks or basins, which shall drain back to the pump station wet well. All structures capable of bypassing shall be controlled by a lockable, manually operated valve. Where such overflows are considered, the department shall be contacted for the necessary treatment or storage requirements. In addition to the required emergency means of operation, where overflows affect public water supplies, a high level wet well overflow and a storage/detention basin, or tank, shall be provided with minimum capacity for two (2)-hour retention of peak hourly flow. Storage/detention tanks or basins shall be designed to drain by gravity or pumping to the station wet well.**

**(F) Storage Capacity. A holding basin with capacity for twenty-four (24)-hour retention of peak hourly flow may be utilized as an emergency operation. The basin must be designed to drain back into the wet well or collection system.**

**(G) Equipment Requirements.**

**1. General. The following general requirements shall apply to all internal combustion engines used to drive auxiliary pumps, service pumps through special drives, or electrical generating equipment:**

**A. Engine protection. The engine shall be protected from operating conditions that would result in damage to equipment. Unless continuous manual supervision is planned, protective equipment shall be capable of shutting down the engine and activating an alarm as required in section (8) of this rule. Protective equipment shall monitor for conditions of low oil pressure and overheating. Oil pressure monitoring will not be required for engines with splash lubrication;**

**B. Placement. The unit shall be bolted in place. Facilities shall be provided for unit removal for purposes of major repair or routine maintenance;**

**C. Controls. Consideration shall be given to provisions for automatic and manual startup and cut-in;**

**D. Size. The engine shall have adequate rated power to start and continuously operate under all connected loads including lighting and ventilating systems in addition to pumping requirements;**

**E. Fuel type. Reliability and ease of starting, especially during cold weather conditions, shall be considered in the selection of the type of fuel. Where public utility gas is selected, consideration shall be given to a generator design that may be operated with an alternate fuel supply system in accordance with the NEC;**

**F. Underground Fuel Storage. Underground fuel storage and piping facilities shall be designed, constructed, operated, and maintained in accordance with 10 CSR 26-2;**

**G. Engine ventilation. The engine shall be located above grade and shall be provided with adequate provisions for heat dissipation and ventilation of fuel vapors and exhaust gases;**

**H. Routine start-up. All emergency equipment shall be provided with instructions indicating the need and frequency for regular starting and running of *[the]* such units at full loads; and**

**I. Protection of equipment. Emergency equipment shall be protected from damage at the restoration of regular electrical power.**

**J. Air quality. Federal, state, and local regulations regarding air quality shall be considered.**

**2. Engine-driven pumping equipment. In addition to the general requirements of paragraph (9)(G)1. of this rule, the following requirements shall apply to permanently-installed or portable engine-driven pumping equipment:**

**A. Pumping capacity. Engine-driven pumps shall meet the design pumping requirements unless storage capacity is available for flows in excess of pump capacity. Pumps shall be designed for anticipated operating conditions, including suction lift if applicable;**

**B. Operation. The engine and pump shall be equipped for automatic start-up and operation of pumping equipment unless manual start-up and operation is justified. Provisions shall also be made for manual start-up. Where manual start-up and operation is justified, storage capacity and alarm system *[must]* shall meet the requirements of section (8) and subparagraph (9)(G)2.C. of this rule; and**

**C. Portable pumping equipment. Where part or all of the engine-driven pumping equipment is portable, sufficient storage capacity with an alarm system shall be provided to allow time for detection of pump station failure and the transportation and hookup of the portable equipment, by means of permanent fixtures at the pump station that will facilitate rapid and easy connection.**

**3. Engine-driven generating equipment. In addition to the general requirements of paragraph (9)(G)1. of this rule, the following requirements shall apply to permanently-installed or portable engine-driven generating equipment:**

**A. Generating capacity.**

**(I) Generating unit size shall be adequate to provide power for pump motor starting current and for lighting, ventilation, and other auxiliary equipment necessary for safety and the proper operation of the pump station.**

**(II) The operation of only one (1) pump during periods of auxiliary power supply shall be justified. Such justification may be made on the basis of the design peak hourly flows relative to single-pump capacity, the anticipated length of power outage, and the storage capacity.**

**(III) Special sequencing controls shall be provided to start pump motors unless the generating equipment has capacity to start all pumps simultaneously with auxiliary equipment operating;**

**B. Operation. Provisions shall be made for automatic and manual start-up and load transfer unless only manual start-up and operation is justified. The generator shall be protected from operating conditions that could result in damage to equipment. Provisions shall be considered to allow the engine to start and stabilize at operating speed before assuming the load. Where manual start-up and transfer is justified, the storage capacity and the alarm system shall meet the requirements of section (8) and subparagraph (9)(G)3.C. of this rule;**

**C. Portable generating equipment. Where portable generating equipment or manual transfer is provided, sufficient storage capacity, with an alarm system, shall be provided to allow time for detection of pump station failure and the transportation and connection of generating equipment. Special electrical connections and double throw switches should be used to connect the portable generating equipment. Electrical energy generating units shall be protected against burnout when normal utility services are restored, and shall have sufficient capacity to provide power for lighting and ventilating system in addition to the pumping units; and**

**D. Provisions for testing. Testing provisions shall be included in the design of paragraph (9)(G)3. of this rule requiring period testing to be accomplished while maintaining electric power to all vital components. Such provisions would involve an ability to conduct tests, such as actuating and resetting automatic transfer switches and starting and loading emergency generating equipment without taking essential equipment off-line. The electric power distribution system and equipment shall be designed to facilitate inspection and maintenance of individual items without interruption of operations.**

**4. Independent utility substations. Where independent substations are used for emergency power, each separate substation and its associated distribution lines shall be capable of starting and operating the pump station at its rated capacity.**

*[(9) Grinder Pumps in Pressure Sewer Systems. A pressure sewer system is defined as two (2) or more grinder pump units at different locations discharging into a common force main. Grinder pump units and pressure systems are not to be used in lieu of conventional gravity collection systems; however, grinder pumps may be used where it is not feasible to provide conventional gravity sewer service, such as where the topography makes it difficult for the users to be served by a conventional system, groundwater conditions make construction and maintenance of a conventional system difficult or excessive rock excavation makes a conventional system*

**Comment [ETC4]:** To be addressed in 10 CSR 20-8.125 Alternative Sewers.

*impractical. The operating authority shall be responsible for the entire system which shall include the force mains, grinder pump units and appurtenances.*

*(A) Pump Openings. The grinder unit must be capable of reducing any material which enters the grinder unit to a size that the materials will pass through the pump unit and force main without plugging or clogging. No screens or other devices requiring regular maintenance may be used to keep trashy or stringy material out of the grinder pump or force main. This requirement shall be in lieu of the requirements in paragraph (4)(C)3. of this rule.*

*(B) Storage Capacity. The minimum storage capacity of the grinder pump unit shall be fifty (50) gallons (189 l). The unit shall be capable of accommodating normal peak flows for periods of eight to twelve (8–12) hours.*

*(C) Alarm System. For grinder pump units serving a single home, an audiovisual alarm capable of alerting the resident and operating personnel in the area may be used in lieu of the alarm system specified in section (7) of this rule.*

*(D) Valves. A gate valve must be provided on the service line near the common force main.*

*(E) Force Main Velocity. The velocity shall meet the requirements of subsection (11)(A) of this rule based on the most probable number of pump units expected to operate simultaneously or on some other acceptable method of computing the peak pumpage rate.*

*(F) Cleaning. Consideration should be given to providing a suitable method of cleaning the force main whenever the velocity in the force main may be less than two feet (2') per second (0.61m/s) before ultimate development is reached.*

*(G) Electrical. Units must be serviceable and replaceable under wet conditions without electrical hazard to repair personnel. Electrical equipment shall be suitable for hazardous locations (National Electrical Code, Class I, Group D, Division 1 location).*

*(H) Standby Units. One (1) standby unit for each fifty (50) units or fraction thereof must be provided for each model installed.*

*(I) Service Interruptions. Provisions shall be made to avoid interruption of service due to mechanical or power failure by providing standby power, storage capacity or interconnection with another disposal system.]*

(10) Instructions and Equipment. *[Sewage]* **Wastewater** pumping stations and *[their operators should]* **portable equipment shall** be supplied with a complete set of operational instructions, including emergency procedures, **and** maintenance schedules*[, special tools and spare parts as may be necessary]*. **Tools and spare parts shall be supplied as necessary.**

(11) Force Mains.

(A) Velocity. At design *[average flow]* **pumping rates,** a **cleansing** velocity of at least two feet *[(2')]* per second **(2 ft/s)** (0.6*[1]* m/s) shall be maintained. **A maximum velocity of eight feet per second (8 ft/s) (2.4 m/s) is recommended to avoid high head loss and protect valves.**

**(B) Minimum Size. The minimum force main diameter for raw wastewater shall not be less than four inches (4") (10 cm) with non-clog pumps except as noted in subsection (4)(G) of this rule.**

*[(B)]* **(C)** Air **and Vacuum** Relief Valve.

**1.** *[An a]***A**ir relief valve**s** shall be placed at high points in the force main to prevent air locking. *[When accumulation of air or decomposition gases are likely, an automatic air relief valve suitable for use on sewage force mains shall be used.]*

**2. Vacuum relief valves may be necessary to relieve negative pressures on force mains. The force main configuration and head conditions should be evaluated as to the need for and placement of vacuum relief valves.**

**3. An air or vacuum relief valve should have an isolation valve between the air relief valve and the force main.**

**4. An air or vacuum relief valve must be inside of a vault that is at least forty eight inches (48") (1.2 m) in diameter and has a vented access opening at least thirty inches (30") (0.76 m) in diameter.**

**5. A force main should have valves spaced at no more than one thousand five hundred foot (1,500') (457.2 m) intervals to facilitate initial testing and subsequent maintenance and repairs.**

**6. The weight of the valve shall not be carried by the pipe. Valves shall be provided with proper support, such as crushed stone, concrete pads, or a well compacted trench bottom.**

*[(C) Termination. Force mains should enter the gravity sewer system at a point not more than two feet (2') (30 cm) above the flow line of the receiving manhole.]*

**(D) Termination. The force main shall enter the receiving manhole with a smooth flow transition to the gravity sewer system at a point not more than one foot (1') (0.3 m) above the flow line. The design shall minimize turbulence and scouring at the point of discharge. Corrosion protection for the receiving manhole shall be provided in accordance with 10 CSR 20-8.120(6)(H).**

**(E) Materials. The pipe materials shall be adapted to local conditions, such as character of industrial wastes, soil characteristics, exceptionally heavy external loadings, internal erosion, corrosion, or similar problems.**

**1. All pipe and joint materials shall conform to the appropriate ASTM specifications. Suitable couplings complying with ASTM specifications shall be used for joining dissimilar materials.**

**2. All pipes shall be designed to prevent damage from superimposed live, dead, and frost-induced loads. Proper allowance for loads on the pipe shall be made because of soil and potential groundwater conditions, as well as the width and depth of trench.**

**3. For new pipe or joint materials for which ASTM standards have not been established, the design engineer shall provide complete material and installation specifications developed on the basis of criteria adequately documented and certified in writing by the manufacturer to be satisfactory for the specific details plans for approval by the department.**

**(F) Installation. Refer to 10 CSR 20-8.120(5)(H)1. through 10 CSR 20-8.120(5)(H)4.**

**(G) Cover. Force mains shall be covered with sufficient earth or other insulation to prevent freezing.**

*[(D)]* **(H) Pipe and** Design Pressure. **Pipe and joints shall be equal to water main strength materials suitable for design conditions.** The force main**,** *[and fittings including]*

reaction blocking**, and station piping** shall be designed to withstand *[normal pressure and pressure surges (water hammer).]* **water hammer pressures and associated cyclic reversal of stresses that are expected with the cycling of wastewater pump stations. The use of surge valves, surge tanks, or other suitable means to protect the force main against severe pressure changes shall be considered.**

**(I) Anchoring. Force mains shall be sufficiently anchored within the pumping station and throughout the line length. The number of bends shall be as few as possible. Thrust blocks, restrained joints, and/or tie rods shall be provided where restraint is needed.**

*[(E)]* **(J)** Special Construction. Force main construction near streams or used for aerial crossings shall meet applicable requirements of 10 CSR 20-8.120(*[9]***8**) and (*[10]***9**).

*[(F)]* **(K)** Design Friction Losses.

**1. Friction coefficient.** Friction losses through force mains shall be based on the Hazen*[ and ]*-Williams formula or other acceptable method **(e.g. the Darcy-Weisbach equation)**. When the Hazen*[ and ]*-Williams formula is used, the *[following]* value*[s]* for "C" shall be *[used for design; unlined iron or steel—]*one hundred (100) **for unlined iron or steel pipe for design.** *[and all other—]* **For other smooth pipe materials such as polyvinyl chloride, polyethylene, lined ductile iron, etc., a higher "C" value, not to exceed** one hundred *[twenty (120)]* **thirty (130), may be allowed for design**.

**2. Maximum power requirements.** When initially installed, force mains will have a significantly higher "C" factor. The **effect of the** higher "C" factor *[should]* **shall** be considered *[only in]* **when** calculating maximum power requirements **and duty cycle time to prevent damage to the motor**. **The effects of higher discharge rates on selected pumps and downstream facilities shall also be considered.**

*[(G) Separation from Water Mains. There shall be at least a ten-foot (10') (3 m) horizontal separation between water mains and sanitary sewer force mains. Force mains crossing water mains shall be laid to provide a minimum vertical distance of eighteen inches (18") (46 cm) between the outside of the force main and the outside of the water main. This shall be the case where the water main is either above or below the force main. At crossings, one (1) full length of water pipe shall be located so both joints will be as far from the force main as possible. Special structural support for the water main and force main may be required.]*

**(L) Protection of Water Supplies. Separation between water mains and sanitary sewer force mains shall comply with 10 CSR 20-8.120(10).**

*[(H)]* **(M)** Identification *[of Force Mains]*. Where force mains are constructed of **a** material *[which]* **that** might cause the force main to be confused with potable water mains, the force main *[should]* **shall** be appropriately identified.

**(N) Leakage Testing. Leakage tests shall be specified including testing methods and leakage limits. Refer to 10 CSR 20-8.120(5)(I)3.**

**(O) Maintenance Considerations. Isolation valves shall be considered where force mains connect into a common force main. Cleanouts at low points and chambers for pig launching and catching shall be considered for any force main to facilitate maintenance.**

**(P) Cleaning. Consideration shall be given to providing a suitable method of cleaning the force main whenever the velocity in the force main may be less than two feet (2') per second (0.61 m/s) before ultimate development is reached.**

**(Q) Septicity. The design shall consider measures to prevent septicity in the force main. Refer to subsection (4)(C) of this rule.**
**(R) Corrosion. Where corrosive conditions due to septicity or other causes are anticipated, corrosion protection of the interior force main shall be provided.**

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